The Role of Clusters in Determining Innovativeness of the Economy – Theoretical Foundations for Empirical Analysis in China and Poland

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Abstract

The Paper focuses on the concept of clusters, which have become an important element of innovation systems at the regional and national level. This is connected with an observation on the special role of of cooperation in innovation processes, regarded as one of the key sources of innovation in the light of the concept of open innovation (OI). The rationale to undertake the research is related to recognized importance of proximity in stimulating innovation processes, and an observed strong geographical polarization of innovation activity at specific regions, the trend which is visible not only in developed countries, but also in emerging economies, like China. It results with innovative clusters emerging very rapidly in both number and scale, for example in better developed provincial economies of coastal China. This signs into wider observation on the structural changes taking place in the world economy, especially the shift of manufacturing activity, including high and medium-high technology industries, to emerging countries. Whereas traditionally, research and development (R&D)-led technological progress was concentrated in the developed countries, which generated most of the innovation, nowadays we witness the emergence of innovation hubs in developing economies, out of which China is making a considerable progress in innovation performance. A significant change in the geography of innovation poses challenges also for Poland, which is trying to build knowledge-based economy and catch-up with innovation leaders. The objective of this Paper is to conduct critical analysis of the theoretical foundations in the area of clusters and their role in determining innovativeness of the economy, as the conceptual background for empirical research on innovation clusters in China and Poland. This research is also related to the scientific problem of convergence in innovation performance between China, Poland, and technological leaders (like USA or Western Europe), with special focus on clusters as one of the factors determining this process.

Keywords: clusters, innovation, China, Poland

1. Introduction

Clusters has become a very important research area, with cluster structures being seen as a key factor influencing entrepreneurship (Pascal 2005), innovativeness and regional development (Porter 1998, 2000). In advanced economies, economic activity, especially in high-tech industries, tends to concentrate around metropolitan areas and specialized regional

clusters (Sölvell 2008, p. 110). Clusters give competitive advantages to co-located firms due to the external economies of scale (Fujita, Krugman, Venables, 2000), eased access to resources and proximity to specialized suppliers and customers (Porter, 1998). Several economists (Porter, 2003; Ketels, 2009) demonstrate a positive relationship between employment in strong clusters and economic performance, meaning that regions with a higher level of specialization in an industry are characterised by higher productivity in this industry.

The classical definition states that clusters are "geographic concentrations of interconnected companies, suppliers, service providers, firms in related industries, and associated institutions (e.g. universities, standards agencies, and trade associations) in particular fields that compete but also cooperate" (Porter 1998, p. 197). From the above definition, we may derive two important characteristics of clusters:
- geographical concentration of companies and other actors in a specific sector, connected with the phenomenon of the regional specialization,
- coopetition between cluster actors, encompassing both competition and cooperation.

One of the difficulty in these research is the ambiguity of the cluster concept itself. According to some representatives of economic geography (Martin and Sunley 2003, p. 9), "*Porter's cluster metaphor is highly generic in character, being sufficiently indeterminate to admit a very wide spectrum of industrial groupings and specialization*". They point out following questions, to which the cluster theory does not give a precise answer: "*At what level of industrial aggregation should a cluster be defined, and what range of related or associated industries and activities should be included? How strong do the linkages between firms have to be? How economically specialized does a local concentration of firms have to be to constitute a cluster?* (Martin and Sunley, 2003, p. 10). The cluster concept gives little attention to the scale of geographical coverage of a group without determining whether clusters exist nationally, regionally or locally (Perry 2007). The difficulties in precisely addressing these challenges are reflected in Porter (1998, p. 204) recognition that cluster boundaries "*rarely conform to standard industrial classification systems, which fail to capture many important actors in competition as well as linkages across industries ... Because parts of a cluster often fall within different traditional industrial or service categories, significant clusters may be obscured or even go unrecognized*".

It is worth to introduce a typology of clusters based on the concept of life cycle, which explains cluster evolution in analogy to the product life cycle. According to this approach, cluster, like a product or even an industry, follows cyclical development patterns. It means that clusters do not represent only temporary solutions to actual problems, but they pass through a number of stages. Although they may not be identical and the pace of their evolution depends on specific circumstances, the life cycle of clusters can be said generally to undergo the stages below:
- emerging cluster, containing a small number of the actors in the agglomeration, which start to cooperate around a core activity, and realize common opportunities through their linkage,
- growing cluster, attracting new actors in the same or related activities, with new linkages developing between all these actors. In many cases, cluster initiative develops its label, website and common connotation,
- mature cluster, which has reached a certain critical mass of actors and has developed both internal and external relations outside of the cluster,

- declining/transforming cluster, starting to experience slowdown in growth and performance, meaning that it has to undertake transformation process and focus on new growth factors, like new market segment, new technology, new methods of delivery of goods, new entrants to the cluster, etc.

Porter (1998) mentions three broad dimensions, in which clusters influence competitiveness:
1) increasing the efficiency and productivity of companies in the region, because of more specialized assets and suppliers with shorter reaction times than they could in isolation,
2) higher levels of innovation, because of close interactions with scientific units, other enterprises and customers, knowledge spillovers, pressure to innovate and possibility to share the costs of R&D,
3) stimulating the formation of new businesses, which expand and strengthen the cluster itself.

The importance of clusters for competitiveness and innovation is connected with a variety of microeconomic benefits, among which the most important are:
- more opportunities to undertake joint R&D activities or other activities aiming at creation of innovation,
- easier access to information on the market (e.g. the current needs of the customers) and the latest technological advances,
- more opportunities to identify market niches and to access to export markets,
- human capital development, as a result of greater mobility of staff and organized trainings and conferences,
- greater access to scarce resources and skills, thanks to their complementarities in cluster structures that facilitate mutual exchange or acquisition between partners (e.g. by centralized purchases),
- increase in production capacity and operational flexibility through greater opportunities to reallocate resources and to use vacant capacity of other economic entities operating in the cluster,
- greater access to customers anticipating changes in the international market,
- opportunity to ensure complementarities of activities with other firms through better matching of offers and the needs of businesses, more efficient roles and functions distribution between them or undertaking of joint marketing activities,
- reducing the level of uncertainty and risk in business activity, by creating an atmosphere of mutual trust in a changing environment,
- increasing the speed of action and enabling rapid response to signals from business environment.

2. Clusters as an element of regional innovation system

Traditionally, the concept of clustering was used in order to explain business success of industrial regions (Cortright 2006). Clusters give competitive advantages to co-located firms due to the external economies of scale (Fujita, Krugman and Venables, 2000), eased access to resources and proximity to specialized suppliers and customers (Porter, 1998). More recently, research in cluster theory has shifted the focus towards innovation-related effects of clustering (Baptista and Swann 1998; Tallman et al., 2004). The role of clusters for innovativeness of companies was analyzed also by Porter (1998: p.261), according to whom "the ultimate test of the health or decline of a cluster is its rate of innovation". Audretsch and

Feldman (2004) argue that clusters stimulate innovativeness since they foster knowledge exchange among companies, individuals, rivals, and knowledge institutions, like universities in close proximity. Moreover, companies in clusters have better access to information than not-clustered firms (Pouder and St. John, 1996).

According to the contemporary paradigm in economics of innovation, new products are mainly the result of cooperation and interactions between 3 types of actors forming Triple Helix model introduced by Etzkowitz and Leydesdorff (1995): industry, university, and government. Traditionally, the concept of clustering was used in order to explain business success of industrial regions as it was highlighted that clusters give competitive advantages to co-located firms due to the external economies of scale (Fujita, Krugman and Venables, 2000), eased access to resources and proximity to specialized suppliers and customers (Porter, 2008). Most of the studies on clusters focus rather on mezzo-economic level as cluster thinking orients economic development policy and practice toward groups of firms and away from individual firms (Cortright 2006).

The impact of clusters on the innovativeness of the economy is connected to the fact that new technologies in specific industrial branches are created in units located in close proximity to each other. Geographical proximity of enterprises and other units helps to build interactions and links between partners, creating significant value added and leading to different effects of synergy. Co-operation among different cluster actors encourage the flow of knowledge, technology transfer, constant learning, as well as generation and absorption of innovations. The effectiveness of the innovation processes in the regional economy is determined by its innovation abilities, especially soft factors playing also an important role in clustering, like: high quality of human and social capital, including relational capital and trust, technological advancement of scientific and research units, entrepreneurship-friendly environment, support from local government and appropriate innovative milieu. All these elements cannot by analyzed separately, but they must constitute a whole system, what is often ensured by developing cluster structure.

Clustering is an effective mechanism of concentration of assets and resources for financing innovative activity, enabling to achieve proper critical mass of private and public investments. Knowledge creation and other forms of innovative activity are more effective in clusters, because they usually include, among others, universities and R&D units. Organizations may benefit from lower costs related to acquisition of external knowledge from their regional partners compared to the potential costs of internal knowledge creation or acquisition it from units located in a significant geographical distance (Harhoff, 2000). Clusters play an important role in constant flows of knowledge and technology transfer from science to business, because they create permanent links between these two sectors. An important role in co-operation processes is played by personal relationships (which are positively influenced by clusters), especially in the case of transferring tacit knowledge, which requires direct communication (Karlsson and Andersson, 2009).

Clusters share similar characteristics with concept of learning regions, according to which the territory must accept the context favorable to the creation and diffusion of knowledge and innovation. The factors driving economic competitiveness of firms, which enable them to effectively operate on the global markets, like: innovation, entrepreneurship, flexibility or network strategies, are generated at the local level. Hence, the success of the region is based mainly on its focus on the learning processes, according to a new paradigm of development, which should be built on existing practical experiences and take into account specificity of

given area (Kowalski, Szlachta, 2007, s. 276). The positive influence of clusters on the innovativeness is revealed in emergence and maintenance of competitive advantage of a location on national and often international level.

3. Internationalization of clusters

3.1 Internationalization as the new phase of clusters development
In the traditional approach, research into clusters focused on their impact on innovation and competitiveness at the mesoeconomic level, which means it primarily concerned benefits gained for the development of a sector or a regional economy. Clusters were therefore regarded as closed production systems, restricted to a specific location and capable of entering into external interactions only at the beginning and at the end of a production chain. Meanwhile, the growing internationalization of the economy – which leads to the removal of trade barriers, strengthens transport and communication systems, and promotes the introduction of uniform market regulations – contributes to more intense cooperation and a international flow of resources, a process reflected in cluster operations. As a result, clusters are taking on new international strategies, such as outsourcing and foreign direct investment to maintain their competitive ability (Rabellotti, Carabelli, Hirsch, 2009). This observation indicates that clusters entered into the next phase of evolution. After local clustering, taking place between actors located in one region, it is time interregional and international co-operation of local clusters.Cluster initiatives increasingly extend beyond the scope of a given location, entering into interactions with actors based in other regions or even countries. According to J. H. Dunning (2002), the fact that cluster operations extend beyond their local areas calls for a revision of conventional models explaining the spatial concentration of economic activity and the role of business clusters in the development of competitiveness.

In modern economy, the understanding of a cluster as a self-contained knowledge hub, based only on internal knowledge exchange and little interactions with the outside world, is under pressure. Economists increasingly recognize the division of knowledge and specialization across clusters, where openness to external knowledge is more and more important following from globalization (Isaksen, Kalsaas, 2009) With globalization, manufacturing is becoming an activity that is much more transferable than initially believed, so clusters and other local production systems open up their borders and to develop interactions with actors outside their regions. As there are many definitions of globalization in economic literature, one of them states that this term means an "increased network of interactions among a growing number of players, as a result of which the situation of individual entities is increasingly dependent on mega- rather than meso-trends" (Hausner, Kudłacz, Szlachta, 1998, p. 14). Hence, in order to maintain their competitive capacity, clusters and the companies they bring together are increasingly working out strategies for the internationalization of their operations, including outsourcing or foreign direct investment (Rabellotti, Carabelli, Hirsch, 2009). According to B. Jankowska and C. Główka (2016, p. 401), the process of internationalization of the cluster can be analyzed at two levels:
1) the top-down approach, with cooperation established at the international level as a result of actions undertaken by the coordinators of cluster initiatives, which concerns formalized clusters,
2) the bottom-up approach, when the internationalization of the cluster is initiated by cluster members, and may apply to both formal cluster initiatives and informal clusters. In this case, the following two types of internationalization may be identified:

a) active internationalization, requiring businesses to venture outside their home market, for example through exports, cooperative relationships, or foreign investment,

b) passive internationalization, meaning that relationships with foreign entities are developed without venturing beyond the domestic market.

In practice, internationalization of the cluster and its member firms usually apply to the following types of activities (Kowalski 2017):

- production, when the profile of companies operating in a cluster needs to be expanded to include the range of complementary resources offered by foreign partners,
- trade, especially in the case of small and medium-sized enterprises (SMEs) belonging to a cluster, as this type of economic units are characterized with lower export abilities,
- research (e.g. undertaking joint R&D or cooperation aiming on the technology transfer), which plays a significant role in the context of internationalization processes involving innovation (so called techno-globalism),
- education and training, when international training programs, conferences, and study visits are organized.

3.2 Network approach to internationalization of clusters and member companies

Network approach proves to be useful when analyzing the role of clusters in the processes of internationalization of firms, as it provides means for understanding the totality of relationships among firms forming industrial systems. By the industrial system, we understand in this context "a network of enterprises engaged in production, distribution and use of goods and services through which lasting business relationships are established, developed and maintained" (Whitelock,2002). Network internationalization model does not assume autonomy of enterprises in their expansion to foreign markets, but highlights that business activities among firms are characterized by interactions and mutual interdependence. Strategies made by companies are influenced by a variety of network relationships, which drive, facilitate or inhibit a firm's internationalization. Enterprises may enter foreign market when they develop a set of exchange relationships, allowing it to continue a business activity in destine location in the long-term perspective.

Clusters and their companies have gone international, searching for new sources of knowledge, new markets and lower labor costs. With the increasing ability of ICT to underpin co-ordination, the role of proximity between different companies and other units loses in importance. The cluster can facilitate the member firms both an access to and development of the necessary resources for their internationalization process. According to the study conducted by G. Meier zuKöcker, L. Müller and Z. Zombori (2011) good network and cluster management systematically reduces some of the barriers to internationalization, as companies engaged in clusters find it easier to cooperate at the international level. This is one of the reasons why network and cluster managements increasingly realize that their responsibility is to act for the sustainable internationalization of their affiliated firms. One of the key factors influencing the internationalization of cluster' affiliated companies is the existence and implementation of a suitable internationalization strategy, meaning that clusters with an internationalization strategy act more successfully on an international scale than those without a strategy. There are also some studies showing that the possibilities of internationalization of a cluster's operations depend on its characteristics and internal structure. For example, research by A. Al-Laham and V. Souitaris (2008) on biotechnology clusters in Germany proves that former experience of cluster initiatives in developing local

and national cooperation has a positive impact on the establishment of international contacts, as it provides skills to carry out joint projects and initiatives, and it is also a signal for potential foreign partners that a cluster has contacts with various actors on the home market. Moreover, the internationalization of clusters is influenced by their organizational diversity, i.e. bringing together different types of organizations, especially renowned research and scientific entities, but also financial institutions, business service providers, suppliers, and associations of professionals from numerous fields. The participation of scientific units plays fundamental role in this process because this increases the reliability of the cluster, and signals its high potential in terms of knowledge and skills.

3.3 Clusters in global value chains

Nowadays, transnational corporations may be treated as a form of inter-organizational networks, which shifted away from their traditional image of hierarchical, center-dominated organizations, in which subsidiaries were engaged in relationships only with the parent company. The need of flexibility to respond to changes in products, technologies and markets transformed transnational corporations into more flexible organizational forms, with higher capability of accommodating novelty and innovation (Arias 1995). Hence, there is growing tendency to perceive international firms as inter-organizational networks, in which the subsidiaries have multiple relationships with other entities both inside and outside the organization's formal boundaries (Birkinshaw et al. 2011). This includes interactions with suppliers, customers and other counterparts, as for each unit, one of the most important resource is the network of specific relationships, in which it is embedded. From this perspective, the transnational corporations are the organizations connecting business relationships in several markets.

An important characteristics of modern global economy is growing international fragmentation of production, which implies that clusters are included in global value chains (GVC). This is connected with the observation on so-called location paradox (M. Porter 2008, p. 252-253) meaning that despite the progressive globalization, a sustainable competitive advantage of business units on international markets is often rooted in the characteristics of regional economy. This observation also concerns clusters, which in many cases are integrated into global value chains. International corporations are developing their chains by acquiring resources specific to a given region, including local knowledge (Bellandi, 2001). This approach leads to a process defined as multiple-embeddedness, whereby enterprises build permanent and in-depth relationships with many industry clusters (Zucchella, 2006). This process is accompanied by a dispersion of cluster value chains into cooperative and competitive relationships between different industrial agglomerations that take either different or identical positions in a value chain (Nadvi, Halder, 2005). This type of de-localization processes constitutes a threat to clusters as it may result in value migration to other regions. However, it may facilitate the inclusion of regional businesses into international networks, thus opening possibilities of expansion into foreign markets. J. Humphrey and H. Schmitz (2002, p. 1020) listed the following methods that can be used to upgrade a cluster as part of a global value chain:
- process upgrading, leading to increased efficiency of processes through the reorganization of a production system or the implementation of advanced technology,
- product upgrading, based on diversifying the product range and manufacturing high-value-added products,
- functional upgrading, based on adopting new functions or replacing the combination of already performed tasks with those that increase the level of specialization,

- inter-sectoral upgrading, based on cluster businesses' undertaking new types of economic activities and entering new value chains while using the competences, which were acquired through prior participation in other value chains.

4. Cluster policy as an element of regional innovation policy

The economic successes of many regional economies, which have developed prosperous cluster structures, are an incentive for public authorities in different parts of the world to prepare strategies and implement programs supporting clustering processes. Cluster policy is emerging as an important element of government actions, which is the topic for many studies (e.g. Benneworth and Charles, 2001; Mariussen, 2001; Raines, 2002; Asheim et al, 2006; Burfitt and Macneill, 2008; Kuchiki, 2008; Ketels, 2009; Schmiedeberg, 2010; Ketels, 2013; Wolman and Hincapie, 2015; Audretsch et al, 2016; Ebbekink, 2016; Kowalski, 2016; Njøs and Jakobsen, 2016; Uyarra and Ramlogan, 2016).

Efforts by public authorities to support clusters fit into the framework of a territorial-based policy, under which both sector-specific and horizontal development measures should have a real impact at the regional and local levels. While the traditional purpose of regional intervention was to reduce development disparities between more developed and less developed regions, the new paradigm of regional policy involves attempts to tap undeveloped potential in all regions in an effort to increasing regional competitiveness (Szlachta, 2009, p. 143). This approach embraces Perroux's (1964) growth pole theory, which identifies sector-specific and territorial growth poles through which business is concentrated. The result is that economic development is polarized, which means that some areas exhibit faster growth than the economy as a whole and have greater potential to achieve an international competitive advantage. The public support channeled to these areas is highly efficient. In addition, cluster policy contributes to building "collective efficiency" in the region, understood as higher, externality-based profits achieved by spatially concentrated businesses (Parrilli, 2009). At the same time, support for clusters may play an important role in the integration of institutional variety in the region, for example by promoting a common vision of development, ensuring a common infrastructure or strengthening coordination mechanisms between various local actors. This process enables cluster organizations to pool resources and combine different types of knowledge, thus contributing to innovation and cluster development. In addition, institutional integration facilitates the pursuit of common interests and coordination of collective efforts, thus leading to deeper specialization in selected market segments (Grillitsch, Asheim, 2015).

Clusters are becoming an important economic policy instrument, as reflected by the cluster-based economic development policy formulated by the OECD (Roelandt, den Hertog, 1999). This is understood as a set of activities and instruments used by authorities at various levels for improving the competitiveness of the economy through stimulating the development of existing cluster systems or creating new systems, primarily at the regional level. At the core of cluster policy is a move away from an individualistic perception of an enterprise in favor of improving its relations with the surrounding environment and a belief that channeling public support to groups of companies instead of individual companies reduces transaction costs and facilitates learning processes. Government intervention to create a network of interactions among local actors catalyzes the comparative advantages of companies and institutions and improves their efficiency.

Together with increasing popularity of clusters as economic policy tool, we can observe significant deviations from original Porter approach, and different trajectories of clusters and cluster policy development around the world. While the majority of studies examine various clusters and related government actions in developed market economies, mostly in the USA and the European Union, far fewer studies have focused on developing countries, in particular in Asia. An interesting question emerges whether the insights acquired through analysing clustering in industrialized countries still hold in the developing economies.

According to Porter (2008, p. 261–271), the main role of government toward clusters may be analysed at two levels:

1) general economy level, by:
   - establishing sound macroeconomic policies, and stable government institutions,
   - improving general microeconomic capacity of the economy,
   - protecting competition to encourage productivity growth,
   - facilitating development and upgrading of all clusters operating in a specific economy, without choosing among them,
   - developing and implementing long-term economic action program to upgrade both the general business environment and the array of local clusters.
2) cluster level, by:
   - reinforcing and building on established and emerging clusters rather than attempting to create entirely new ones,
   - finding an area of specialization and building on local sources of uniqueness,
   - attracting multiple companies in the same field, including FDI, by developing specialized training, infrastructure, and other aspects of the business environment.

There are different strategies, models, and instruments of cluster policy adopted in different countries, however, they usually may be categorized as representing one of two dominant approaches, or their mix (Fromhold-Eisebith and Eisebith, 2005; Borrás and Tsagdis, 2008; Ketels*et al*, 2012; Ebbekink and Lagendijk, 2013; Obadić, 2013; Lehmann and Benner, 2015; Uyarra and Ramlogan, 2016):

- implicit bottom-up approach, with clusters driven mostly by market forces, and the key role played by enterprises,
- explicit top-down approach, where clusters are emerging and developing mostly as a result of government actions.

When evaluating the use of clusters as an economic policy instrument, it is necessary to make a valid assumption that the cluster concept is primarily a business model based on the functioning of market mechanisms in which enterprises play a dominant role. The use of this model to shape public policies is a secondary issue. Various mechanisms related to the functioning of a market economy, such as agglomeration externalities, lead to the concentration of economic activity in a specific area and cluster development. Consequently, the main determinant of this process is the "invisible hand of the market." A separate issue is a decision by public authorities to lend additional support to the development of cluster initiatives.

This viewpoint on cluster policy stays in contrast with experiences of many developing countries, especially in Asia. There is an attempt to in the literature to describe the Asian model of cluster policy. According to Pessoa (2012), this model combines both: top-down approach with bottom-up approach. However, in the origin it is always a top-down approach,

as the government acts not only as a catalyst and mediator but also setting national priorities and devising a challenging vision for the future. The Asian model policy is based on a sequence of actions described by Kuchiki (2008) as the flowchart approach, which stresses the importance of the ordering of policy measures.

Conclusions

The research conducted in this Papershowed that clusters constitute an important element of regional innovations systems, which is connected to the fact that new technologies in specific industrial branches are created in units located in close proximity to each other. The effectiveness of the innovation processes in the regional economy is determined by its innovation abilities, especially soft factors playing also an important role in clustering, like: high quality of human and social capital, including relational capital and trust, technological advancement of scientific and research units, entrepreneurship-friendly environment, support from local government and appropriate innovative milieu.

The analysis shows that internationalization is becoming a key direction in the development of clusters, which are beginning to go beyond their local frameworks for cooperation and are entering into international cooperation networks, in many cases becoming an important part of global value chains. The research shows that one of the benefits that cluster members derive from participation in a cluster initiative is greater opportunities to find partners abroad and participate in international projects. This process results in better access to markets in different countries and a higher level of exports as well as access to innovative technology and global sources of knowledge and information. Another benefit of cluster development in the context of international cooperation is that it increases the locational advantages of regions and helps them attract foreign direct investment, which plays a significant role as economies strongly compete for external capital.

Cluster policy has become an important element of regional innovation policy, which is reflected by the cluster-based economic development policy formulated by the OECD. However, together with increasing popularity of clusters as economic policy tool, we can observe significant deviations from original Porter approach, and different trajectories of clusters and cluster policy development around the world. In particular, there is an attempt to in the literature to describe the Asian model of cluster policy, which combines top-down approach with bottom-up approach.

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